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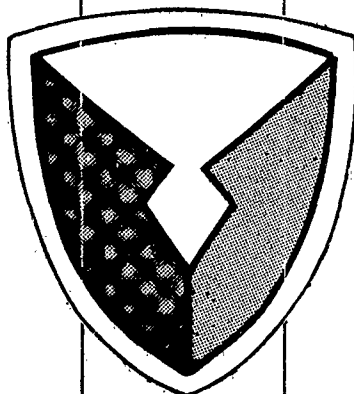
MEMORANDUM REPORT
M63-21-1

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REPORT M63-21-1



FRANKFORD ARSENAL

XM12 ROCKET CATAPULT FOR DOUGLAS RB66 AIRPLANE

by

A. Benditt

OMS 5110.22.011
DA Project 5S02-06-001

January 1963

PHILADELPHIA 37, PA.

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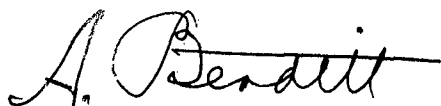
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Frankford Arsenal
Philadelphia 37, Pa.

Memorandum Report M63-21-1
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DA Project 5S02-06-001

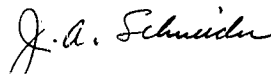
XM12 ROCKET CATAPULT FOR DOUGLAS RB66 AIRPLANE

Prepared by:



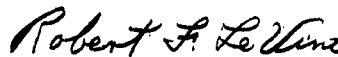
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ABSTRACT

This report describes the testing of nine Frankford Arsenal XM12 rocket catapults with the Douglas Aircraft RB66 airplane. The results show that the performance of the XM12 catapult was satisfactory and that it will safely eject the designated seat-man system throughout the operational speeds and altitude range of the B-RB66 series aircraft.

INTRODUCTION

Frankford Arsenal furnished Douglas Aircraft Company with nine XM12 rocket catapults for testing with the RB66 airplane. This plane carries a crew of three with the pilot and gunner in tandem and the navigator adjacent to the gunner.

TESTING

The first group of three units was fired from a single sled at Edwards Air Force Base on 21 May 1959 at a speed of mach 0.92 and was described in Douglas Aviation Engineering Report No. LB-30197. The units were triggered at 0.35-second intervals. Two of the units functioned satisfactorily, while the rocket grain in the other failed to ignite following catapult function. With reference to the successful firings, the trajectory heights were approximately 90 feet. Six additional units were fired as described in Douglas Aviation Report No. LB-30315. A brief summary of their test history and test data in tabular form follows.

One unit was fired statically and attained a height of approximately 140 feet. Two units were fired together from a sled at approximately 115 knots and attained heights of approximately 75 ft. Three units were fired from a sled at a target speed of mach 0.92, one of which had a poor trajectory due to the sled supporting structure failing upon firing. There was no failure of the catapult.

| <u>Test Run</u> | <u>Seat</u> | <u>Speed (knots)</u> | <u>Trajectory Height (ft)</u> |
|-----------------|-------------|--------------------------|-----------------------------------|
| I | Pilot | 0 | 142 |
| II | Pilot | 118 | 74 |
| | Navigator | 111 | 77 |
| III | Pilot | 610 | 48 |
| | Navigator | 606 | * |
| | Gunner | 555 | 48 |

*Sled support structure failure. 1

DISCUSSION

The XM12 rocket catapults reported herein are identical to the qualified M8 rocket catapult with the exception of the head which was modified to permit the thrust line of the 45° nozzle to align with the center of gravity of the seat-man mass.

The XM12 rocket catapult, as designed and tested, meets the requirements of the work statement (Appendix A) submitted by Aeronautical Systems Division and the design requirements (Appendix B) established by the Propellant Actuated Devices Division of Frankford Arsenal.

CONCLUSIONS

Report No. LB-30315 states that the performance of the catapults was satisfactory for all tests despite the failure of the sled support structure and concluded that the XM12 catapult will safely eject the designated seat-man system throughout the operational speeds and altitude range of the B-RB66 series aircraft.

RECOMMENDATION

It was recommended by Douglas Aircraft that the XM12 rocket catapult be retrofitted on all upward ejection seats on the B-RB66 series airplanes.

APPENDIX A

WORK STATEMENT MODIFICATION OF RAPEC UNIT

19 October 1959
WS-60-5

1. The Ordnance Corps shall modify the Bureau of Ordnance RAPEC Rocket Catapult and fabricate, test, and furnish to WADC a rocket catapult in accordance with Specification MIL-C-25918 and the requirements specified herein.

1.1 MODEL DESIGNATION

The catapult shall be designated: Catapult, Aircraft Personnel, XM12.

2. GENERAL REQUIREMENTS

2.1 LOCKING REQUIREMENTS

The fastenings used to secure external and internal parts shall withstand a breakaway torque of 400 to 200 inch pounds min., respectively.

2.2 ASSEMBLY AND DISASSEMBLY

2.2.1 The catapult shall be designed so that complete disassembly may be made without part destruction.

2.2.2 The catapult shall be designed so that no part shall be capable of being assembled in such a way as to produce malfunction.

2.3 MECHANICAL COMPONENTS

2.3.1 The gas inlet port shall be in accordance with AND-10050-4.

2.3.2 Screw threads shall conform to the requirements of the 1950 Supplement to Screw Threads Standards for Federal Services, No. H28.

2.3.3 Workmanship on all parts shall conform to high grade aeronautical practice.

3. DETAIL REQUIREMENTS

3.1 MECHANICAL DESIGN

| | | |
|-------|---|---------------|
| 3.1.1 | Catapult stroke | 40 inches |
| 3.1.2 | Overall length | 50-1/8 inches |
| 3.1.3 | Diameter | 3-1/8 inches |
| 3.1.4 | Strength in tension | 4000 lbs min |
| 3.1.5 | Strength in compression | 8000 lbs min |
| 3.1.6 | Pressure required to actuate firing mechanism (propellant gas actuated) | 1000 psi |
| 3.1.7 | Catapult weight | 30 lbs. max. |

3.2 BALLISTIC REQUIREMENTS

| | | |
|-------|--------------------------------|-------------------|
| 3.2.1 | Operating temperature range | -65° F to +200° F |
| 3.2.2 | Exit velocity | |
| | a. at end of catapult stroke | 40 fps min |
| | b. at rocket burnout | 110 fps min |
| 3.2.3 | Acceleration | 20g max |
| 3.2.4 | Rate of change in acceleration | 300g/sec max |
| 3.2.5 | Ignition delay | .150 sec max |
| 3.2.6 | Weight propelled vertically | 350 lbs |

4. A final report, in WADC Technical Report format, covering the development of the catapult, including assumptions, sample calculations (ballistic and mechanical), performance data, other test data, photographs, technical data, disassembly and assembly procedures and drawing numbers shall be submitted to the WADC upon completion of development. This report shall be in reproducible form and submitted to WCLSJC for reproduction and distribution.

5. REMARKS

5.1 Reference

5.1.1 Specification MIL-C-25918 (USAF).

APPENDIX B

DESIGN REQUIREMENTS FOR CATAPULT, AIRCRAFT PERSONNEL, XM12

ABenditt/aab/22126
Ordnance Corps Project TS1-15
Pitman-Dunn Laboratories
Frankford Arsenal
12 May 1959
Catapult, Aircraft Personnel, XM12
Design Requirements No. FA-1421-
DR-C-223-1

1. Scope and Classification

1.1 Scope

This specification covers the requirements for an aircraft personnel catapult designed to be used in aircraft emergency escape systems. The device is intended for upward ejection of a crewman with ejection seat and related equipment, and shall be powered by propellant gases generated by firing cartridges contained in the unit.

1.2 Model Designation

The catapult shall be designated: Catapult, Aircraft Personnel, XM12.

2. Applicable Specifications, Drawings, and Publications

2.1 Specifications

MIL-E-5272A - "Environmental Testing, Aeronautical and Associated Equipment"

MIL-P-12011 - "Painting and Finishes of Fire Control Instruments"

MIL-S-5626 - "Steel; Chrome Molybdenum (4104)
Bars, Rods, and Forging Stock
(for Aircraft Applications)"

MIL-T-20155 - "Seamless Tubing, Molybdenum
Alloy Steel"

2.2 Drawings

Should be prepared using FA-LXP-3 manual as a guide.

2.3 Publications

Engineering manual, cartridge actuated devices for
aircraft use, Frankford Arsenal.

3. General Requirements

3.1 Locking requirements

The fastenings used to secure external and internal
parts shall withstand a breakaway torque of 400 and
200 inch pounds min. , respectively.

3.2 Assembly and Disassembly

3.2.1 The catapult shall be designed so that complete
disassembly may be made without part destruc-
tion.

3.2.2 The catapult shall be designed so that no part
shall be capable of being assembled in such a
way as to produce malfunction.

3.2.3 The catapult shall be fitted with a distinctive
ordnance seal which must be destroyed in
order to disassemble the device.

3.3 Environmental

3.3.1 Sufficient protection shall be provided to in-
sure satisfactory operation after tests pre-
scribed by Specification MIL-E-5272A,
Procedure 1, under the following conditions:

High and Low Temperature
Humidity
Sand and Dust
Salt Spray

- 3.3.2 The catapult shall be capable of withstanding the following vibration tests:
- 3.3.2.1 Total time 150 hours min., acceleration $\pm 3g$.
 - 3.3.2.2 The item shall be vibrated 50 hours min. at -65° , $+70^{\circ}$, and $+160^{\circ}$ F, respectively.
 - 3.3.2.3 The item shall be vibrated a min. of 50 hours in each of three planes and a min. of 16-2/3 hours at -65° , $+70^{\circ}$, and $+160^{\circ}$ F, respectively, in each of these planes. The three planes of vibration are:
 - 3.3.2.3.1 Catapult mounted vertically; motion of the item shall be vertical.
 - 3.3.2.3.2 Catapult mounted horizontally; motion of the item shall be vertical.
 - 3.3.2.3.3 Catapult mounted horizontally; motion of the item shall be horizontal.
 - 3.3.2.4 The catapult shall be vibrated to determine resonant frequency of the item.
 - 3.3.2.5 The catapult shall be vibrated at the frequency corresponding to the resonant frequency, or 200 cycles per second if the resonant frequency is above 200 cycles per second, for the total time of the test.

3.3.3 The cartridge seals shall be adequate to withstand 14 psi pressure differential cycling tests.

3.4 Mechanical Components

3.4.1 The gas inlet part shall be 1/8-27 N.P.T. as requested by Douglas Aircraft.

3.4.2 Screw threads shall conform to the requirements of the 1950 Supplement to Screw Threads Standards for Federal Service, No. H28.

3.4.3 Workmanship on all parts shall conform to high grade aeronautical practice.

3.5 Reliability

The catapult shall be designed to have a reliability factor such that not more than one failure to function will occur in 10,000 firings. A statistical evaluation of firing tests shall be made to show that performance reliability of the unit over the temperature range -65° to +160° F equals or exceeds three sigma limits.

4. Detail Requirements

4.1 Mechanical Design

| | | |
|-------|---|----------------|
| 4.1.1 | Catapult stroke | 40 inches |
| 4.1.2 | Overall length | 50-1/8 inches |
| 4.1.3 | Diameter | 3-1/8 inches |
| 4.1.4 | Strength in tension | 4000 lbs. min. |
| 4.1.5 | Strength in compression | 8000 lbs. min. |
| 4.1.6 | Pressure required to actuate firing mechanism (propellant gas actuated) | 1000 psi. |
| 4.1.7 | Catapult weight | 30 lbs. max. |

4.2 Ballistic Requirements

4.2.1 Operating temperature range -65° to +160° F.

4.2.2 Exit velocity

- a. at end of catapult stroke 40 fps min.
- b. at rocket burnout 110 fps min.

4.2.3 Acceleration 20g max.

4.2.4 Rate of acceleration 300g/sec max.

4.2.5 Ignition delay 150 m-sec max.

4.2.6 Weight propelled vertically 350 lbs.

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